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**OFFICE OF NAVAL RESEARCH**

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# EUROPEAN SCIENTIFIC NOTES

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**15 September 1954**

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# OFFICE OF NAVAL RESEARCH
London

# EUROPEAN SCIENTIFIC NOTES

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## THE GLASGOW CONFERENCE ON NUCLEAR PHYSICS

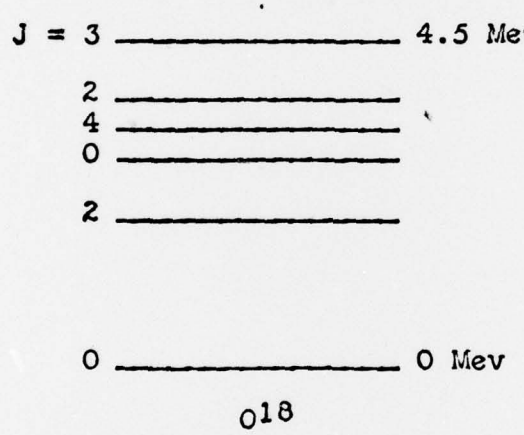
The International Union of Pure and Applied Physics together with UNESCO sponsored the International Conference on Nuclear Physics at the University of Glasgow on 13 - 17 July 1954. This Conference was attended by about 270 delegates and was organized by the Department of Natural Philosophy of the University of Glasgow under the direction of Prof. P. I. Dee. The subjects discussed at the Conference included most of the active fields of nuclear physics with principal sessions on nucleon scattering, nuclear states, theoretical nuclear models, beta and gamma ray transitions, $\pi$ mesons (both experiment and theory), and a concluding session on heavy mesons and hyperons. Two groups of parallel sessions were also held on specialized topics such as photo disintegration, field theory, detailed meson theory, high energy experimental techniques. etc.

Drs. J. R. Holt and K. W. Allen from the University of Liverpool reported on some recent results obtained with deuteron stripping. One report concerned the results on the (d,n) reaction obtained with a new fast neutron spectrometer based on the time of flight of the secondary electrons produced in the ionization chamber. An interesting comparison for seven of the analog states of the two nuclei $P^{29}$ and $Si^{29}$ was obtained in this way.

Another experiment which they reported is of interest because it shows the applicability of a new technique involving the angular correlation between the nucleon product of the stripping reaction and the succeeding gamma ray from the product nucleus in its excited state. The example used was $Si^{28}(d,p)\ Si^{29*}(\gamma)\ Si^{29}$ which for the ordinary stripping investigation yields a curve with a maximum at $30^{\circ}$ to the incident deuteron corresponding to the capture of neutrons with angular momentum $l_n = 2$ yielding the state at 1.28 Mev.

| | | $d^3$ | $d^2s$ | $ds^2$ | $s^3$ |
|---|---|---|---|---|---|
| | $O^{19}$ | 89 | 1 | 10 | - |
| $F^{19}$ | $3/2+$ | 63 | 12 | 25 | - |
| $F^{19}$ | $5/2+$ | 65 | 13 | 22 | - |
| $F^{19}$ | $\frac{1}{2}+$ | 12 | 59 | - | 29 |

The same methods were applied to the nucleus $F^{18}$ with the result that for $V_0 < 30$ Mev the predicted ground state for this nucleus would have $J = 5$ while for $V_0 > 30$ Mev it would have $J = 0$ (experimentally $J = 0$). Finally, a predicted level diagram for the nucleus $O^{18}$ was presented, showing the even parity states only, and employing $V_0 = 45$ Mev. This is shown in the following figure.




$O^{18}$

Dr. A. H. Wapstra of Amsterdam reported some work done at Uppsala and Stockholm on isomeric states in lead and thallium. Among other items he showed a table of the energies of the first two excited states in the odd isotopes of thallium relative to the ground state $s\frac{1}{2}$.

| Tl | 203 | 201 | 199 | 197 |
|---|---|---|---|---|
| $d\frac{5}{2}$ | 679 kev | 692 | 722 | 774 |
| $d\frac{3}{2}$ | 279 | 331 | 367 | 388 |
| $s\frac{1}{2}$ | 0 | 0 | 0 | 0 |

This table shows an interesting progression in the energies of the two excited states as pairs of neutrons are removed.

Further details of this Conference are given in Technical Report ONRL-72-54. The complete proceedings will be published by the Pergamon Press Ltd., London.

## INDUCED LATTICE CHANGE IN PHOSPHORUS

Dr. H. Krebs of the Chemical Institute, University of Bonn, has been able to produce black phosphorus from yellow phosphorus without the use of high pressure. Mercury serves as the catalyst and temperatures in the neighborhood of 380°C are required. The materials are sealed in a glass tube in an inert atmosphere, such as nitrogen, care being taken to use enough mercury to allow for vaporization. The mercury must be well dispersed to provide sufficient surface area. For small quantities of the order of a gram it is necessary only to shake the tube to break up the mercury into a large number of very small globules. For larger quantities some other method is required, as for example the introduction of a number of small copper-plated iron wires, so that the mercury will form an amalgam on the wire surface. Often there is trouble with the formation of red phosphorus if insufficient finely divided mercury is used or if the changes are too slow. A small amount of black phosphorus introduced with the original materials apparently insures against this.

An explanation of the phenomenon is provided in terms of the binding forces and lattice structure in phosphorus and the desired asymmetry in the structure introduced by coherency with a metallic surface. A full account of the work is being published in Die Naturwissenschaften in the near future. Krebs' work on the influence of directional forces associated with electron valence configurations on the formation of specific lattice types was summarized in ESN 7, 245 (1953).

## STABILIZATION OF FREE ATOMS AND RADICALS

A variety of interesting new results have been obtained by Dr. G. Porter and his collaborators (Cambridge) during the past year concerning the stabilization and the spectra of free radicals and of molecules in excited states. Since Dr. Porter will give a comprehensive review of this work at the New York meeting of the American Chemical

Society, only a few of the most interesting results will be briefly mentioned here.

Perhaps the most noteworthy are the results obtained using extremely simple substances and techniques, which indicate that the simplest alkyl radicals can probably be maintained in a stable form for a long time under suitable conditions. After irradiating dilute solutions of the simplest alkyl iodides in a suitable solvent which forms a glass at liquid nitrogen temperatures, it was found that upon warming the solution iodine is formed. Both a continuous high pressure mercury source and the 2536A line of mercury were used in these experiments and the solvents employed were the ones developed by G. N. Lewis and his school in their work on the properties of excited states in aromatic molecules.

It should be noted that the most clearcut results are obtained using a mixture of hydrocarbons as the solvent, while the results obtained in EPA (5 parts ether, 5 parts isopentane, 2 parts alcohol) show a curious anomaly not yet fully understood. Irradiating a dilute solution of iodine in the hydrocarbon solvent at low temperatures, the color disappears and reappears upon warming, in good agreement with the results obtained with the alkyl iodides. In EPA, however, it was noted that the iodine color does not reappear (in the case of iodine solutions) or appear (in the case of alkyl iodide solutions) until about ten minutes after the solution reached room temperature, and appropriate longer times at lower temperatures. A tentative explanation may be provided in terms of an alcohol complex but it is not easy to envisage a detailed mechanism of this delay process.

The observations indicate beyond doubt that in these glassy solvents at low temperatures free iodine atoms must be present, separated from one another by solvent molecules in a rigid medium and they react to form iodine molecules when the rigidity has decreased to a suitable point. It is most likely that the excess kinetic energy of the dissociation products is dissipated by warming the rigid solvent molecules in their immediate vicinity; this enables the dissociation products to move far enough apart so that they cannot interact. The kinetics of the iodine formation has been studied and the method offers interesting possibilities to study the effect of different other molecules on the collision processes involved. The observations also make it extremely likely that the other dissociation product, i.e. methyl or ethyl radical, is also stabilized in these low temperature systems. No direct observations have been made on these species, however, but such experiments are planned.

Thus it may be possible to get some spectroscopic or magnetic information on the methyl free radical and thereby decide the question of its correct shape.

## THERMODYNAMICS OF GASES SORBED IN ZEOLITES

Since his return from the National Research Laboratories in Ottawa, Dr. G. L. Kington (Aberdeen) has been investigating the thermodynamics of gases sorbed in crystalline solids. It will be recalled that this field has been largely explored by Prof. R. M. Barrer and his collaborators in Aberdeen during the past few years and Dr. Kington's results both extend and confirm their conclusions.

In a theoretical study, using a simple Lennard-Jones 6-12 force law, Dr. Kington has shown that molecules somewhat larger than the size of the channels in the zeolite can be sorbed. This is equivalent to saying that a potential barrier has to be surmounted for sorption to take place and this can occur if the net process is still exothermic, i.e. if one does not have to go too far on the repulsive side of the potential curve. This is a valuable factor to consider whenever sorption results are correlated with "effective sizes" of the sorbed species.

A detailed experimental study was made of the sorption of argon in a suitable chabazite (sodium-calcium-aluminosilicate); this included the measurement of heats of sorption using an improved Beebe type calorimeter and detailed isotherm data. The results confirm previous views of Barrer, et al. that these systems give ideal Langmuir type isotherms and that the differential heats of sorption are almost constant when measured as a function of amount sorbed. The sorbing system is nearly homogeneous, consisting of arrays of equivalent lattice points, and corners, edges, and planes are absent.

The availability of both heat and entropy data on these systems enabled Dr. Kington to try various models in an effort to obtain a more refined idea of the state of the sorbed argon molecules. The best fit with experiment is obtained with a model which formally assigns to the sorbed argon molecules one translational and two vibrational degrees of freedom; if these latter are assumed identical they correspond to a loose vibrational frequency of about $10^{12} sec^{-1}$.

## CONFERENCE ON MECHANICAL EFFECTS OF DISLOCATIONS IN CRYSTALS

The two-day Conference on the Mechanical Effects of Dislocations in Crystals which was recently held at the University of Birmingham attracted well over 200 participants from more than a dozen countries, including a large group of American visitors. Some twenty papers dealing with various aspects of the plastic behavior of crystals were presented, with major emphasis on the dislocation approach to such problems as slip and work-hardening in metals. Publication of the proceedings is not contemplated but a summary of the more significant European contributions may be found in Technical Report ONRL-70-54.

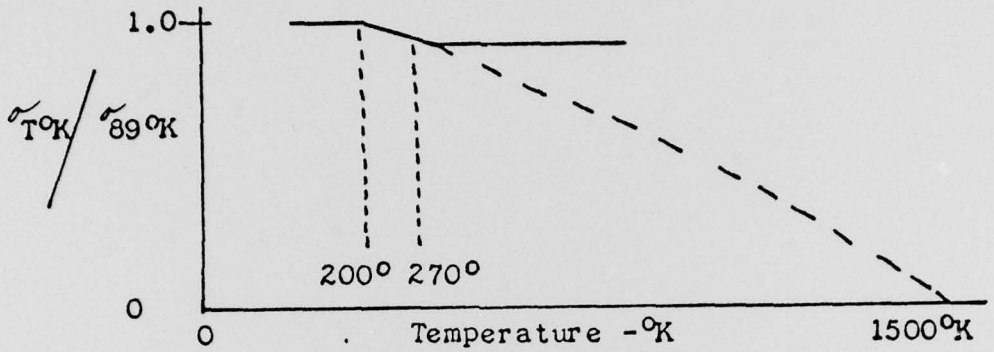
### The Temperature Dependence of the Flow Stress in Work-hardened Crystals

One of the more interesting papers was given by Prof. A. H. Cottrell (Birmingham) who described some experiments aimed at estimating the extent to which a "forest" of screw dislocations intersecting the glide plane contributes to work-hardening. According to Cottrell, it is reasonable to expect that the process by which slip dislocations cut through such a forest should be thermally-activated, and that inasmuch as this so-called cutting process involves the formation of dislocation jogs, it should be strongly dependent upon temperature. To check this prediction, the temperature dependence of the flow stress was measured in work-hardened single crystals of Al and Cu. Crystals of the same orientation were strained in tension at various temperatures between approximately 100° and 500°K and, in each case, the test was then continued at liquid air temperature (89°K). In this way, the temperature dependence of the flow stress corresponding to a given amount of work-hardening could be determined. This practice also eliminated work-softening effects, such as were observed, for example, when Al crystals were strain-hardened at low temperatures and then tested at some higher temperature (see Stokes and Cottrell, Acta Met. 2, 341 (1954)).

With Al single crystals it was found that the flow stress at temperature T°K, relative to that at 89°K, remained remarkably constant over a wide range of strain-hardening. Moreover, after correcting for the temperature dependence of the shear modulus, $\mu$, using the data of Köster, the flow stress ratio

$$\sigma_{T^\circ K} / \sigma_{89^\circ K}$$

did not show any significant variation with temperature over the entire temperature range investigated. When the same experiments were repeated with Cu single crystals, however, somewhat different results were obtained. Thus, after making allowance for the change in shear modulus with temperature, three distinct ranges of temperature dependence were observed, as shown schematically in the accompanying figure.




Cottrell has interpreted these results as follows: At temperatures below 200°K, where thermal fluctuations are relatively unimportant, it is energetically easier for the dislocations to "by-pass" rather than cut through the forest; this by-passing process is insensitive to temperature except insofar as it depends on $\mu$. In the intermediate temperature range from roughly 200° to 270°K, a sufficient amount of thermal activation is provided to enable the dislocations to cut through the forest, the activation energy required being related to the energy of formation of a dislocation jog. At room temperature and above, the stress which is necessary to drive the dislocations through the forest becomes less than that required for the operation of Frank-Read sources; consequently, no additional temperature dependence, aside from the normal effect of temperature on $\mu$, is manifest at higher temperatures.

On the basis of a simple model for the temperature-activated movement of the dislocations, Cottrell has calculated that in Cu, the forest should become completely transparent at a temperature of approximately 1400°K; extrapolation of the flow stress data yields a value which lies somewhere between 1200° and 1500°. The fact that Al and Cu behave somewhat differently seems to be related to the difference in jog energies in these two metals. Recent

calculations by Seegar (Stuttgart), for example, place the energy of a dislocation jog in Al at only about 0.5 ev as compared to roughly 4 ev for Cu. It is therefore unlikely, according to Cottrell, that the temperature-activated movement of dislocations through the forest will be observed in Al.

## THE UPTAKE OF $P^{32}$ AS AN IN VITRO TEST OF THE VIABILITY OF STORED SKIN

At the Second Radioisotope Conference, Oxford, 19 - 23 July, Drs. W. Gemmell, J. E. Laing and N. Veall of the Plastic Surgery Center, Odstock Hospital, Salisbury, and the Physics Department, Guy's Hospital, London, reported an empirical observation to the effect that skin intended for grafting could be tested for viability by incubating it in a suitable Ringer's solution containing $P^{32}$ as orthophosphate. A sharp cork borer is used to obtain sections of skin 6 millimeters in diameter. These are weighed and incubated at 37°C in 10 to 20 ml of Ringer's solution containing $P^{32}$ with a specific activity of one μc/ml. The $P^{32}$ uptake is determined at regular intervals over a period of four hours. Skin which is dead shows little or no $P^{32}$ uptake while viable skin has a $P^{32}$ uptake which is approximately an inverse exponential function of time with a half period of two hours. From the practical point of view it has been found that a negative test is followed by clinical failure of the graft, while the graft which shows a normal $P^{32}$ uptake has a good chance of survival, other factors being equal. It is hoped that this test will be of value in surveying methods and conditions of storage of skin as well as for determining the viability of individual specimens intended for grafting.

Further information on the contributions made at this Conference is given in Technical Report ONRL-65-54.

## PERSONAL NEWS ITEM

Prof. Hans A. Krebs of the University of Sheffield has been appointed to succeed Sir Rudolph Peters as Professor of Biochemistry at the University of Oxford.

## TECHNICAL REPORTS OF ONRL

The following reports have been forwarded to ONR, Washington. Copies may be obtained by addressing requests

to the Commanding Officer, Office of Naval Research Branch Office, Navy No. 100, c/o Fleet Post Office, New York, N.Y.

ONRL-56-54 "The Department of Physiology, Charing Cross Hospital Medical School, London University" by W. D. Neff

ONRL-57-54 "The Eighty-ninth Meeting of the Pathological Society of Great Britain and Ireland" by J. L. Tullis

ONRL-58-54 "Psychology at the University of Oslo, Norway" by W. D. Neff

ONRL-62-54 "Aerodynamic Research in Sweden" by W. D. Hayes

ONRL-63-54 "Further Studies on the Syndrome of Radiation Sickness" by J. L. Tullis

ONRL-64-54 "The Institute of Applied Psychology of the University of Stockholm" by W. D. Neff

ONRL-65-54 "Notes on the Second Radioisotope Conference at Oxford" by J. L. Tullis

ONRL-66-54 "A New Synthesis of Ethylene Derivatives" by J. C. Sheehan

ONRL-67-54 "Psychology at Cambridge and Oxford" by W. D. Neff

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